

# Chapter 1

1. In case of an accident, there is a high chance of getting lost. The transportation cost is very high each time. However, if the infrastructure is set once, it will be very easy to use it repeatedly. Time for wireless transmission is negligible as signals travel at the speed of light.
2. Advantages of bursty data communication
  - (a) Pulses are made very narrow, so multipaths are resolvable
  - (b) The transmission device needs to be switched on for less time.

Disadvantages

- (a) Bandwidth required is very high
  - (b) Peak transmit power can be very high.
3.  $P_b = 10^{-12}$   
 $\frac{1}{2\bar{\gamma}} = 10^{-12}$   
 $\bar{\gamma} = \frac{10^{12}}{2} = 5 \times 10^{11}$  (very high)
  4. Geo: 35,786 Km above earth  $\Rightarrow RTT = \frac{2 \times 35786 \times 10^3}{c} = 0.2386s$   
 Meo: 8,000- 20,000 Km above earth  $\Rightarrow RTT = \frac{2 \times 8000 \times 10^3}{c} = 0.0533s$   
 Leo: 500- 2,000 Km above earth  $\Rightarrow RTT = \frac{2 \times 500 \times 10^3}{c} = 0.0033s$   
 Only Leo satellites as delay =  $3.3ms < 30ms$

5.

6. optimum no. of data user = d  
 optimum no. of voice user = v  
 Three different cases:  
 Case 1: d=0, v=6  
 $\Rightarrow revenue = 60.80.2 = 0.96$

Case 2: d=1, v=3

revenue = [prob. of having one data user] × (revenue of having one data user)  
 + [prob. of having two data user] × (revenue of having two data user)  
 + [prob. of having one voice user] × (revenue of having one voice user)  
 + [prob. of having two voice user] × (revenue of having two voice user)  
 + [prob. of having three or more voice user] × (revenue in this case)

$$\begin{aligned} \Rightarrow & 0.5^2 \binom{2}{1} \times \$1 + 0.5^2 \times \$1 + \binom{6}{1} 0.8 \times 0.2^5 \times \$0.2 + \binom{6}{2} 0.8^2 \times 0.2^4 \times \$0.4 + \\ & \left[ 1 - \binom{6}{1} 0.8 \times 0.2^5 \times \$0.2 - \binom{6}{2} 0.8^2 \times 0.2^4 \times \$0.4 \right] \times \$0.6 \\ \Rightarrow & \$1.35 \end{aligned}$$

Case 3: d=2, v=0

revenue =  $2 \times 0.5 = \$1$

So the best case is case 2, which is to allocate 60kHz to data and 60kHz to voice.

- 7.
8.
  1. Hand-off becomes a big problem.
  2. Inter-cell interference is very high and should be mitigated to get reasonable SINR.
  3. Infrastructure cost is another problem.
9. Smaller the reuse distance, larger the number of users who can use the same system resource and so capacity (data rate per unit bandwidth) increases.
10.
  - (a) 100 cells, 100 users/cell  $\Rightarrow$  10,000 users
  - (b) 100 users/cell  $\Rightarrow$  2500 cells required  
 $\frac{100km^2}{Area/cell} = 2500cells \Rightarrow \frac{Area}{cell} = .04km^2$
  - (c) From Rappaport or iteration of formula, we get that  $100 \frac{channels}{cell} \Rightarrow 89 \frac{channels}{cell}$  @  $P_b = .02$   
 Each subscriber generates  $\frac{1}{30}$  of an Erlang of traffic.  
 Thus, each cell can support  $30 \times 89 = 2670$  subscribers  
 Macrocell:  $2670 \times 100 \Rightarrow 267,000$  subscribers  
 Microcell: 6,675,000 subscribers
  - (d) Macrocell: \$50 M  
 Microcell: \$1.25 B
  - (e) Macrocell: \$13.35 M/month  $\Rightarrow$  3.75 months *approx* 4 months to recoup  
 Microcell: \$333.75 M/month  $\Rightarrow$  3.75 months *approx* 4 months to recoup
11. One CDPD line : 19.2Kbps  
 average  $W_{imax} \sim 40Mbps$   
 $\therefore$  number of CDPD lines  $\sim 2 \times 10^3$